1 Background

Performing high levels of daily physical activity (PA [movement]) is linked with better health in adolescents. PA can be categorised into different intensities:

- **Light PA (LPA):** can sing whilst doing the activity
- **Moderate PA (MPA):** can talk but not sing during the activity
- **Vigorous PA (VPA):** cannot say more than a few words without pausing for breath

There are guidelines to perform LPA and MPA at 60 minutes per day of moderate-to-vigorous PA [1]. These guidelines can be completed by performing only MPA.

It has not been clear how much activity at what intensity is needed to improve health in young people, but PA might be most important [2]. Currently, most teenagers in the UK (80%) do not meet the World Health Organization’s PA guidelines [3], suggesting a new approach is needed.

Our research aims to determine which PA intensity is most strongly linked with cardiovascular health markers. We also aimed to identify the duration at each intensity associated with the healthiest cardiovascular health profile in adolescents.

2 What we did

Collected data from 12–18-year-olds with and without overweight/obesity who participated in the OxoSOCRATES study (NCT014118543).

- PA: 7–days of wrist-worn accelerometer 
- (movement of the wrist)

Statistical analyses – multiple linear regression, moving average models, and rank-based group tests. Done to determine the independent strength of relationships between each PA intensity with cardiovascular health markers.

These analyses took into account the known confounding effect between PA intensities (e.g., if you do more MPA then you typically do more VPA), and the effects of age, sex, puberty status, and amount of body fat on cardiovascular health markers. This meant that each PA intensity result was unique to that intensity.

r values – closer to 1 means stronger relationship (can be positive or negative).

3.1 Body Fat

Having more body fat is known to be linked with worse health in adolescents, but we do not know whether a particular PA intensity is best for reducing body fat.

**Body fat** – bioelectrical impedance analysis in 84 adolescents (n=47 male, n=30 overweight/obese).

Only VPA had a clear and independent relationship with body fat. Adolescents who performed an average of 23 minutes/day of VPA had the greatest benefit.

![Figure 1: Differences in body fat by quartiles of VPA.](image)

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3.2 Cardiorespiratory Fitness

Better cardiorespiratory fitness level is known to result in better health. However, we do not know whether a particular intensity is best for improving fitness.

Cardiorespiratory fitness – bleep test in 339 adolescents (n=170 male, n=103 overweight/obese) and cardiorespiratory exercise test 82 adolescents (n=45 male, n=28 overweight/obese)

Only VPA had a clear and independent relationship with fitness. More averaged VPA per day improved fitness up to about 20 minutes/day, beyond which there was not much improvement (Figure 2 & 3) [4]. This did not depend on how much body fat adolescents had (n=0.51, p=0.001).

![Figure 2: Relationship of VPA with cardiorespiratory fitness (bleep test). Lower (Q1 = red) and upper (Q4 = blue) quartiles.](image)

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3.3 Heart Function

Diastolic function is a term for how the heart relaxes. As it worsens, the heart eventually develops diastolic heart failure, which is a common and life-threatening condition, particularly in people with overweight and obesity.

Adolescents with obesity have worse diastolic function [5], but it is not clear whether PA can prevent this.

Diastolic function – ultrasound of the heart in 81 adolescents (n=44 male, n=30 overweight/obese).

The septal early-to-late diastolic peak velocity ratio was found as the optimum measure of diastolic function [5].

Only adolescents who did more averaged VPA per day had better diastolic function.

![Figure 3: Relationship of VPA with cardiorespiratory fitness (cardiorespiratory exercise test).](image)

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3.4 Insulin Resistance

Insulin resistance is an important marker of health and increasing resistance is a step towards Type 2 Diabetes.

57 adolescents (n=36 male, n=30 overweight/obese) fasted overnight and had blood samples taken before and after a liquid meal challenge to measure insulin resistance.

Only higher VPA was associated with reduced insulin resistance (r = -0.50, p = 0.002). However, this was driven by increased body fat as relationships were removed when body fat was included.

![Figure 4: Differences in diastolic function by quartiles of VPA.](image)

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4 Conclusions

- Only VPA was linked with these important cardiovascular health outcomes, independently of other intensities.
- VPA may protect against the detrimental impact of excess body fat.
- Benefits were maximal in this population at around 20 minutes of VPA per day.
- As the current PA guidelines can be satisfied by only undertaking MPA, with no apparent independent benefit on body fat, fitness, insulin resistance, and diastolic heart function, we provide evidence for specific VPA recommendations to improve these aspects of health in adolescents.

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** References **


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**The Case for Vigorous Physical Activity in Adolescents**

**Evidence from the OxoSOCRATES Study**

**S. J. Burden, 1,2,3 B. D. Weedon, 1,2 P. Gunawan, 2 A. Turner, 1,2 L. Whayman, 2 A. Meaney, 2 H. Dawes, 1,2,4,5 A. Jones 2**

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